Your response

Question	Your response
Question 1: Do you have comments on the overall approach to the review?	Confidential? – N It's an impressive document. There is very good thinking behind the approach. Ten years however is a very long time period and it might be better to have split it into immediate, mid term and long term aspirations.
Question 2: Have we captured the major trends that are likely to impact spectrum management over the next ten years?	Confidential? – N The document covers frequency sharing well, but doesn't look at the time domain. Within a network an operator will manage interference through the use of spreading codes. There is an opportunity to manage sharing of the same frequencies between different users by doing this. One area which is missed is that regulation has not kept up with devices being much better at co-existing than has ever been anticipated. Improved radio technology, filtering and protocols have meant, and will continue to mean that there is more flexibility in allocating spectrum in areas where in the past interference would have been a problem.
Question 3: Could any of the future technologies we have identified in Annex 6, or any others, have disruptive implications for how spectrum is managed in the future? When might those implications emerge?	Confidential? – N It's hard to see an application for blockchain. In bitcoin the network is powered by miners keeping the blockchain updated. In a blockchain without a cryptocurrency it's hard to understand the financial incentive to provide the computing power. There are lots of problems with number porting but the client-server model is not one of them. The 'closed shop' of the MNOs and Syniverse is the barrier to entry. Just changing the number storage doesn't alleviate this. There may be a blockchain model for the dynamic distributed use of spectrum which we propose in our answer to question 11. AI in mobile networks is like AI in everything, it's just a new computing technique. It's not a future trend it's here now and will continue to be used. We would like to see AI used to speed up the granting of routine applications.

	Self-organising networks are essential for the model we propose and in orgainsing networks where spectrum is shared in both frequencies and time domains.
Question 4: Do you agree that there is likely to be greater demand for local access to spectrum in the future? Do you agree with our proposal to consider further options for localised spectrum access when authorising new access to spectrum?	Confidential? – N Yes, driven by IoT and in particular Ofcom should look at spectrum which is currently only licenced for indoor use to make it available outdoors. This is particularly true of venues like sports stadia – even big ones like motor racing circuits and horse racing. And in industrial environments where manufacturing may take place over a number of buildings and there needs to be tracking across a whole site
Question 5: Do you agree with the actual and perceived barriers identified for innovation in new wireless technologies, and our proposed ways of tackling those?	Confidential? – N If the aim is to liberalise spectrum the barriers are not that great. If it's to liberalise connectivity it need to take into account the other, political barriers. In particular issues with MNOs dragging their feet on granting Local Access Licences, charging unrealistic admin fees and refusing while not using the spectrum they hold licences for. But problems go beyon spectrum to ECC, interconnect and issuing of mobile network codes/
Question 6: Do you agree with Ofcom's proposals to improve our outreach and reporting activities, and spectrum information tools? • **Are there additional ways that Ofcom could better engage with existing and future users and providers of wireless communications?** • **Please explain any specific areas where you believe more or better provision of information could provide value to stakeholders**	Confidential? – N The proposals are excellent
Question 7: Do you agree that it is important to make more spectrum available for innovation before its long-term use is certain? Do you have any comments about our proposed approach to doing this?	Confidential? – N Yes. This has worked very well with the TV white space projects
Question 8: Do you agree that it is important to encourage spectrum users to be 'good neighbours' to ensure more efficient use of the spectrum? Do you agree with our proposals to:	Confidential? – N We strongly support these proposals. As devices become more intelligent they are better able to cope with interference. Taking this into account is a good way to optimise the

a) increase realism in coexistence analysis at a national and international level? **b) encourage spectrum users to be more resilient to interference?** **c) ensure an efficient balance between the level of interference protection given to one service and the flexibility for others to transmit?** **Do you have any comments on which of these will be the most important?**	use of spectrum. Software defined radio means that economy of scale is less important as devices can be built in volume and only use small amounts of spectrum in a particular region.
Question 9: Are there any other issues or potential future challenges that should be considered as part of this strategy?	Confidential? – N There needs to be a mechanism for standardising waveforms to allow tow users into the same spectrum but to co-exist
Question 10: Do you agree that continued use of our existing spectrum management tools (as set out in sections 4-7) will be relevant and important for promoting our objectives in the future, in light of future trends?	Confidential? – N Yes, there are lessons which can be learned from the US deployment of CBRS in this respect
Question 11: Is there anything else we should be considering doing, or doing differently, to promote our objectives?	Confidential? – N Ofcom is the world leader in innovative use of spectrum. It's often been hard for the industry to keep up. But ten years is a very long time so as brave as the proposals seem now it is perhaps time for a radical rethink about spectrum sharing. The current paper works very well for a migration from what we have now to what Telet Research proposes: an end to spectrum licencing. Stepping back we need to understand the purpose of spectrum licencing. It's being done to provide the best use of radio spectrum and provide companies with the know-how and need to use it efficiently. But those buying the licences don't want spectrum, they want to provide a service and spectrum is just one of the component parts. We propose a move to a model where the networks control who has access to what, dynamically. This is a step beyond spectrum sharing. While, by its nature Ofcom has to

concern itself with all form of radio we'll limit ourselves to cellular technologies.

We envisage s system where the network monitors coverage. Every cell reports what it can hear from the rest of the network. This provides a national, real-time map of coverage and quality of service. This can be supplemented by a database which logs the location of every dropped connection.

In our model, when a base station comes on-air it listens to find out what is available, it cross-references this with a central database of what is being used nearby and through a policy based on most efficient use chooses what spectrum to operate in. This may well be a large number of aggregated frequencies. Adjoining cells report the propagation to improve the accuracy of the database.

This means all registered users have access to all the spectrum which is not being used at that moment in time. In the current model it's expected that a licence holder has access to spectrum even if it is not being used. This extends to the operator having land-grab rights even in locations where suitable equipment for that spectrum is not deployed.

The monetisation for government in this lies in the policy. Companies pay for propriety. A rich company with millions of users may choose to be very high priority. It can ensure the quality of service at the optimum spectrum by out-bidding its rivals. Small company, community and campus networks can then bid for less bandwidth at lower prices.

A farmer might pay very little for coverage of his or her fields for the vast majority of the time, tracking livestock and doing spectral analysis on crops. But as train rattles through the licence switches to the major mobile network operator paying for priority and then returning the spectrum to the farmer when the train has passed. This ensures that the spectrum is used all the time and not just when there is a train traversing the field.

The mechanism works well for temporary events such as music festivals where it's

	uneconomic to put coverage in which is unused save for a few days a year. In this new model Spectrum licensing is replaced by access licencing. Which is after all why people are buying licences in the first place.